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# Remote Sensing Approach for Urban Planning Based on Heat Island Study

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\*This report is included some works before and is not limited to the paper  
accepted by this conference. So the topic is changed.

# Three questions I have thought continuously in urban heat island study

## 1. Why should we study “heat island”?

Saving energy, enhancing the comfort level of human settlement

## 2. Who will use the result of “heat island” study?

Urban planner, decision maker of government

## 3. How can we make “heat island” study consummately?

Do the research based on interdisciplinary

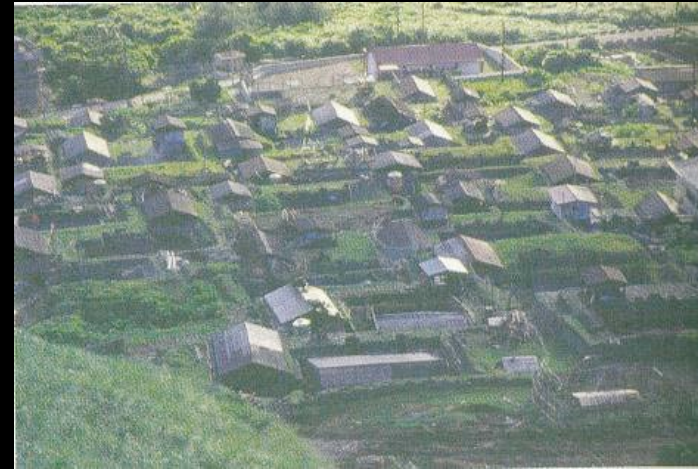
## Therefore...

1. Heat island study should be based on the need of urban planning.
2. Heat island study should be not limited in its own discipline and should do comparative and combinative study of every related subjects. Digital method, such as Remote Sensing, can be used to assist the research.

Remote Sensing, the tool for space study is used in our research and to form an urban planning approach based on the study of heat island. The analysis of heat island at urban scale and community scale using Remote Sensing technology will be an important way to assist urban planning and make it more reasonable.

# Relationship between urban planning and heat environment

Urban planning is one of the main causes of urban heat island generation. Unreasonable planning can result in exacerbation of the urban heat island effect, worsening microclimate environment, and lowering the human settlement level which results in more energy consumptions and pollution. So urban planning should seek an approach to suit local climate and decrease the effect of the heat island.



(Source of these two images: Xiande Lin. 2007. Green Architecture. Beijing: China Architecture & Building Press: 52-53)

# Remote Sensing technology

Satellite image can be used  
in heat island research :

## Low resolution:

➤ Modis

## Media resolution:

➤ ETM/TM

➤ CBERS (19.5m for band  
resolution)

➤ Aster

## High resolution:

➤ QuickBird

➤ IKONOS

➤ SPOT

➤ CBERS-02B HR images

➤ Google earth



( Pseudo-colors of ETM image in July 9,2002 )

# Research approach

The approach which is formed to deal with the relationship between heat island and urban planning should break up the limitation of each profession and consider about the heat environment. It can be deduced like following way.

- Urban condition at medium scale will be analyzed. This step will use medium resolution satellite images to deduce certain indexes of underlying surface, such as surface temperature index and vegetation index, to analyze the medium scale characteristics of urban area and its heat environment.
- Then high resolution satellite images are used to analyze the land utilization of the focused community, underlying surface classification and landform characteristic which will make the research field clearly studied. In this step, planners can analyze the characteristic of planning and its influence on the heat island combined with the analysis result of medium resolution satellite image. Thus the flaws in community planning can be found.

Based on studies above and existing condition of buildings, roads and landscape, final revision plans can be summarized and provide reference for other relative projects.

# Points for attention

- Digital study should be closely related with real design and planning of target area. Therefore, the approach can have applicability for real heat island research.
- The research of urban heat island should not be limited to the detection of temperature index but should include the indexes of vegetation overlay, water surface and styles of buildings in the group.
- The static value is the representation of heat environment of one spot and one time only and will change continuously. The characteristic and space structure of heat environment basing on the change of time and environment in the city should be the focus.

# Heat island study at urban scale

## Related articles:

1. Kun LI and Zhuang Yu. Relationship between city layout and heat environment based on remote sensing technology: a case study of Wuhan city. City Planning Review, 2008, 32 (5): 75-82.
2. Kun Li, Zhuang Yu. Comparative and Combinative Study of Urban Heat island in Wuhan City with Remote Sensing and CFD Simulation . SENSORS.2008.8 (10): 6692-6703

# Collection of background material

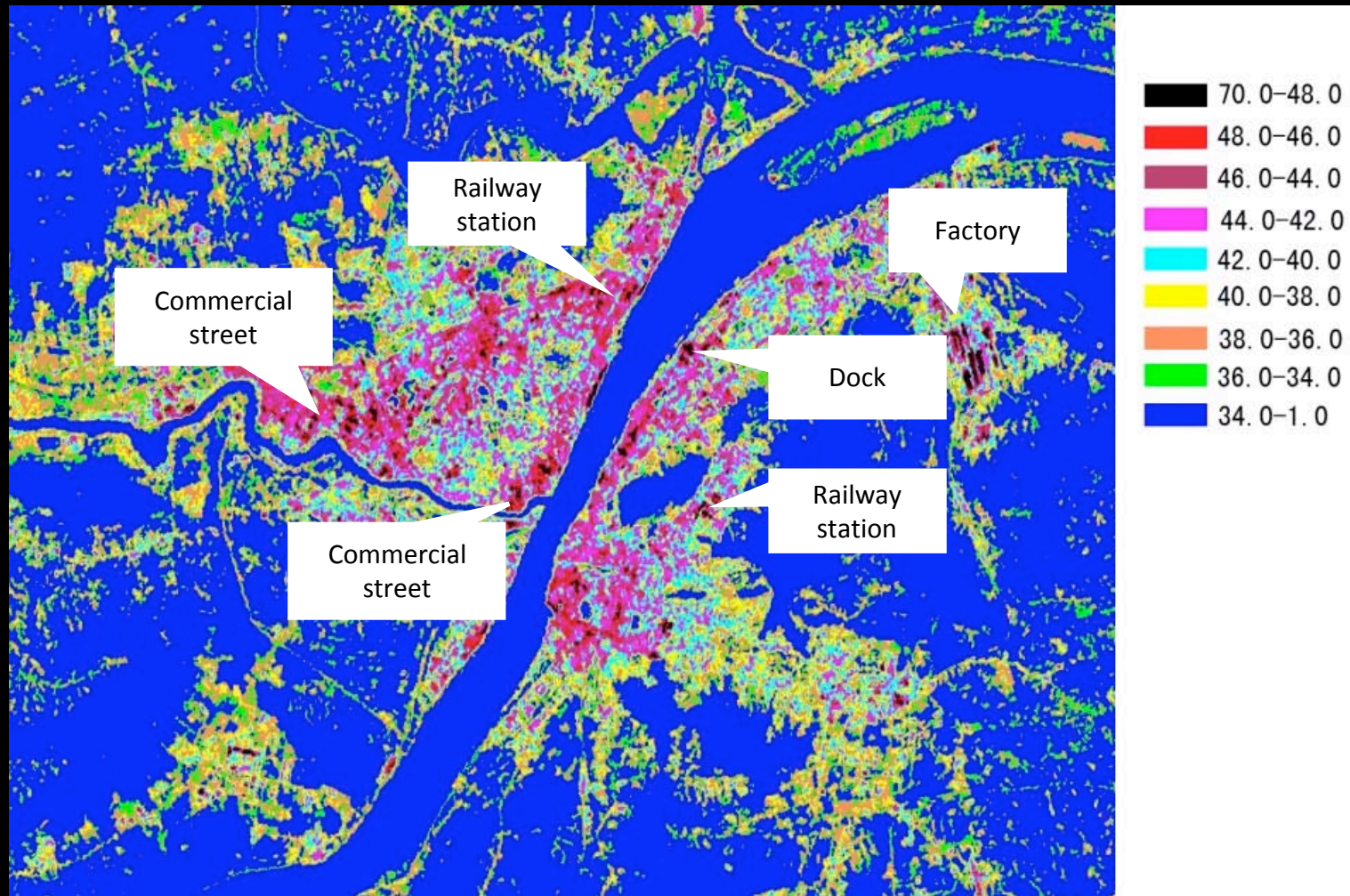
(Site analysis using RS satellite images of high resolution)

- The compose of underlying surface
- The characteristics of urban planning
- The characteristics of landform



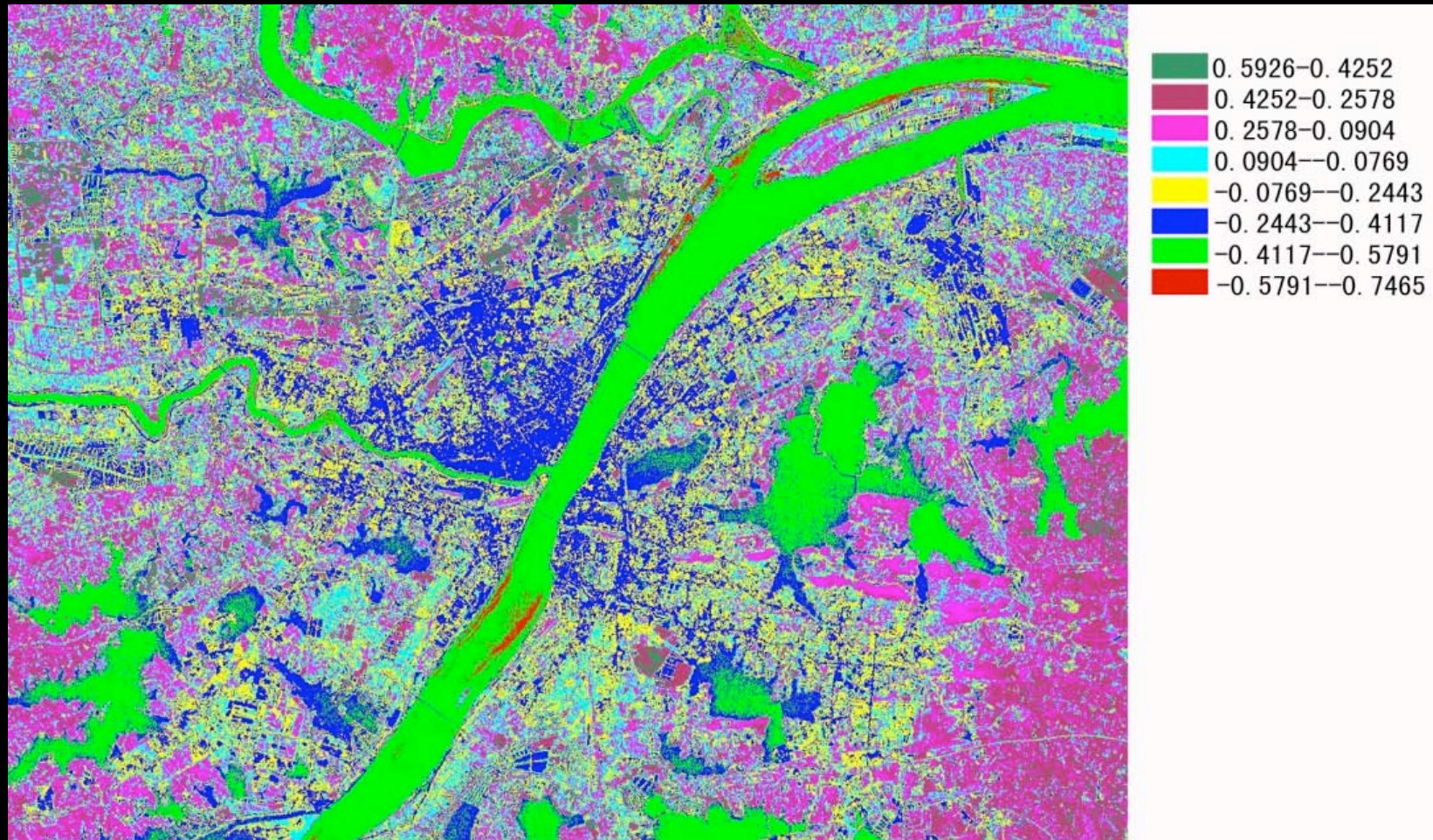
(Quickbird satellite image)

# Inverse image (July 9, 2002) of Land surface temperature of Wuhan city, China



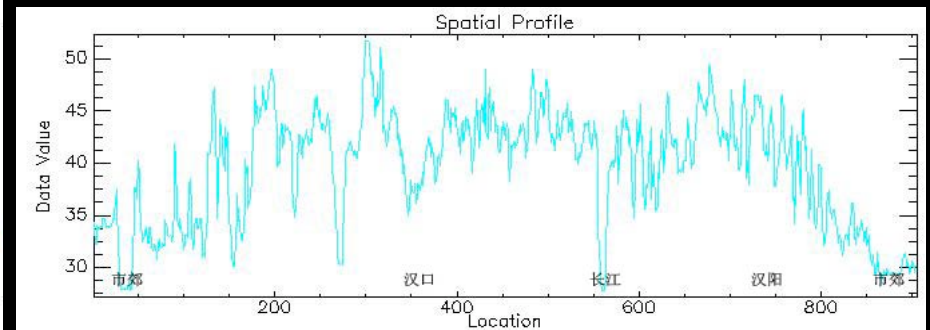
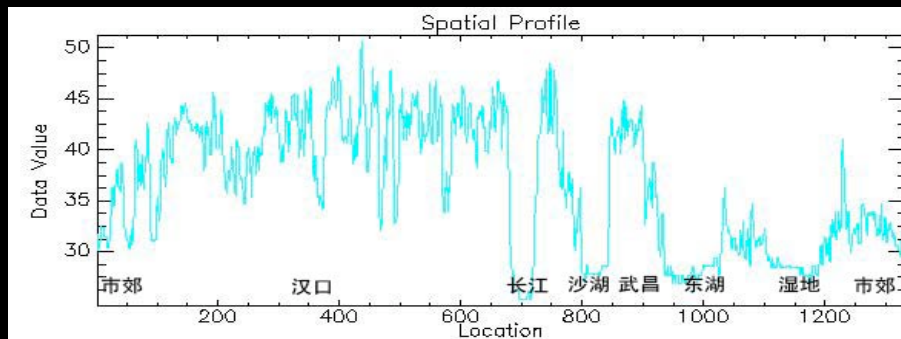
(Deduced from ETM satellite image)

# Inverse image (July 9, 2002) of NDVI of Wuhan city, China



(Deduced from ETM satellite image)

# Profile of urban heat environment (July 9, 2002)



(Deduced from ETM satellite image)

# Comparison of indices of land surface spots

Name	Land surface pattern	Land surface temperature in July 19 <sup>th</sup> , 1991 (°C)	NDVI on July 19 <sup>th</sup> , 1991	Land surface temperature on July 9 <sup>th</sup> , 2002 (°C)	NDVI on July 9 <sup>th</sup> , 2002
Hanzheng street	Commercial street	33.873688	-0.1	45.816256	-0.350427
Jiefang park	Green park	26.13504	0.348837	32.089508	0.204301
Zhongshan park	Green park	28.264862	0.16129	35.433502	0.159664
Wuhan steel plant	Factory	36.295788	-0.090909	55.130981	-0.25
Wuchang railway station	Traffic architecture	33.845154	-0.111111	45.852692	-0.341772
Guanggu square	Commercial building	30.487366	0.257732	41.7742	-0.244186
Xudong square	Commercial building	28.991302	0.207547	43.166731	-0.101604
Wuhan square	Commercial building	33.25412	0.08046	38.343536	-0.320388
Wenhua lane	Old city region	33.091064	-0.090909	46.032379	-0.302632
Jiqin Street	Old city region	32.419464	0.111111	42.206299	-0.314286
Guishan TV. tower	Green park	26.043304	0.37931	33.854095	0.146853
Qintai street	Traffic node	29.112122	-0.045455	35.436462	-0.270073
Yingwu state	Normal city region	34.66684	-0.103448	47.785339	-0.251613
Dongfeng stamping company	Factory	25.8414	0.452991	54.78064	-0.312977
Huazhong University of Science & Technology	University	27.517944	0.431818	40.284821	-0.008
Wuhan heavy hanging wall machine tool plant	Factory	34.070038	0.052632	44.867493	-0.045455

# Heat island study at community scale

# A case used for heat island study

The case study will concentrate on Tsinghua University, which is a university in Beijing, China P. R.. It is a special community, which divides into several parts such as teaching area, dormitory area, greening area and so on. Vegetation underlying surface in the campus is plentiful and concentrated. Building underlying surface lays orderly and water surface is obvious. So this study area has usual underlying surfaces and can reflect the characteristic of urban heat island.

The study use satellite image of high resolution and medium resolution. ASTER satellite image is used as the medium resolution image; it has five thermal infrared bands with resolutions of 90 m. CBERS-02B HR images with spatial resolution of 2.35 m is used as the high resolution satellite image . It can represent the information of underlying surface and can investigate the study area carefully.

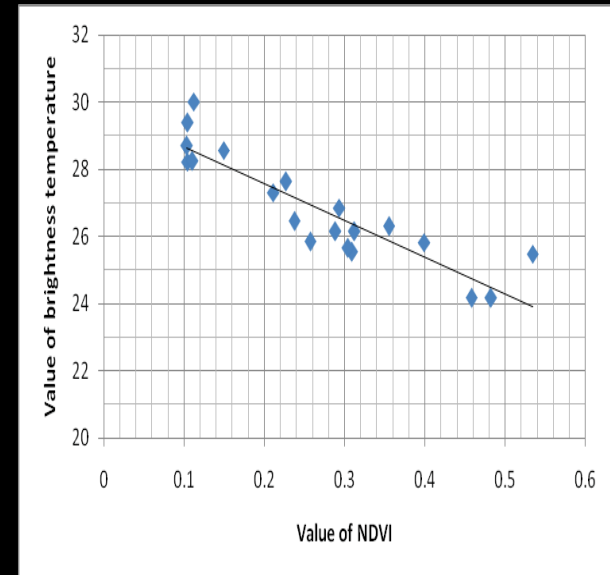
# Relationship between brightness temperature and NDVI



**The Image of Brightness  
Temperature Calculated from  
ASTER Satellite Image**



**The Image of NDVI  
Calculated from ASTER Satellite  
Image**



**Scatter Diagram of  
Brightness Temperature (°C) and  
NDVI**

(Deduced from ASTER data in April 22, 2006)

# Percentage of underlying surface of three areas

In the case, three different areas are selected to do the classification of underlying surface and to make the condition of these areas clearly, using high resolution band of CBERS satellite image with resolution is 2.35m (Dec. 6, 2007).

Teaching area						
Surfaces	Total area	Building	Road	Piazza	Lawn	Trees
Percentage	100%	35.0%	7.6%	11.6%	3.2%	42.6%
Administrative area						
Surfaces	Total area	Building and road	Water	Vegetated surface		
Percentage	100%	22.0%	8.4%	69.6%		
Dormitory area						
Surfaces	Total area	Building	Road	Vegetated surface		
Percentage	100%	37.8%	32.0%	30.2%		

# Teaching area analysis

The first area selected is the teaching area which is at the east part of campus. The main types of underlying surface of this area are buildings, roads and piazzas, lawns, forests. Buildings occupy very large percentage and will raise the brightness temperature. Roads and piazzas also have large percentage and do the same function. However, buildings are arranged in orderly ranks along the roads. This benefits the ventilation and can bring the heat out. What's more, vegetated surfaces have sizeable area and can decrease the intensity of heat island. So this area is a high temperature part of the campus but it still remains the appropriate condition.



# Administrative area analysis

The second area selected is the administrative area in campus. This area is also made up by buildings and roads, water surfaces, lawn and vegetated surfaces. The area's greening coverage occupies a large percentage and has beautiful landscape . The greening surface here can prevent the radiation of sunlight and absorb much heat. The water surface can also stabilize the temperature. Buildings and roads in the area are few and many of them are sheltered by trees. So the temperature of this area is relative low.



# Dormitory area analysis

The third area selected is the dormitory area in campus which has proper proportion between building and plant area. The classifications of underlying surface are including: buildings, roads and vegetated surfaces. Buildings are arranged in rows and the spaces among buildings are enough for ventilation. Vegetated surfaces are in abundance among the buildings and greening condition of adjacent area is good. Most buildings in this area are multilayer buildings and are not very high. All these can benefit a lessened heat island.



# Conclusion

- Traditional urban planning can not provide effective measures to detect underlying surface and the structure of heat island. Using Remote Sensing technologies to do relevant research can guide the real planning projects more scientifically.
- Some satellite image at medium scale can do whole research but they are not very fine. Heat island of small scale is hard in research because of the requirement of high precision of observing ground objects. Thermal infrared band of the satellite is needed in analyzing the structure of heat island but it has only medium resolution and can not do the fine research which should be remedied by high resolution. How to use various scales of satellite images should be carefully arranged.
- Each types of underlying surface should be kept at a reasonable percentage. Buildings and roads will make heat island more serious but too little building will limit the requirement of human beings. Therefore, measures such as multilayer building, enough space among buildings and planting vegetations as possible may be efficient for decreasing the effect of urban heat island.

**Thank You !**